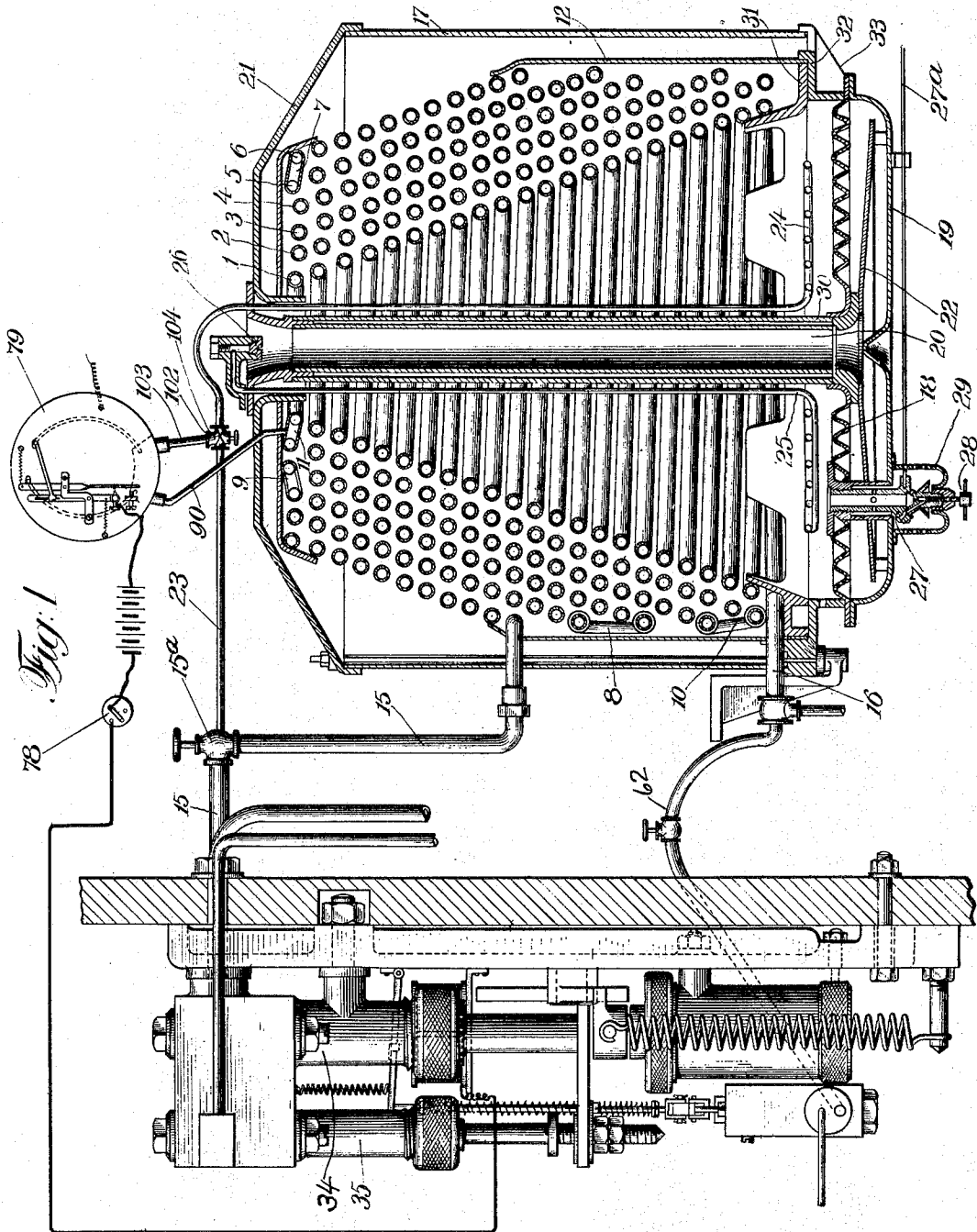


E. C. NEWCOMB.
AUTOMATIC REGULATOR.
APPLICATION FILED NOV. 16, 1909.

981,104.

Patented Jan. 10, 1911.

3 SHEETS—SHEET 1.



Witnesses:
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Inventor

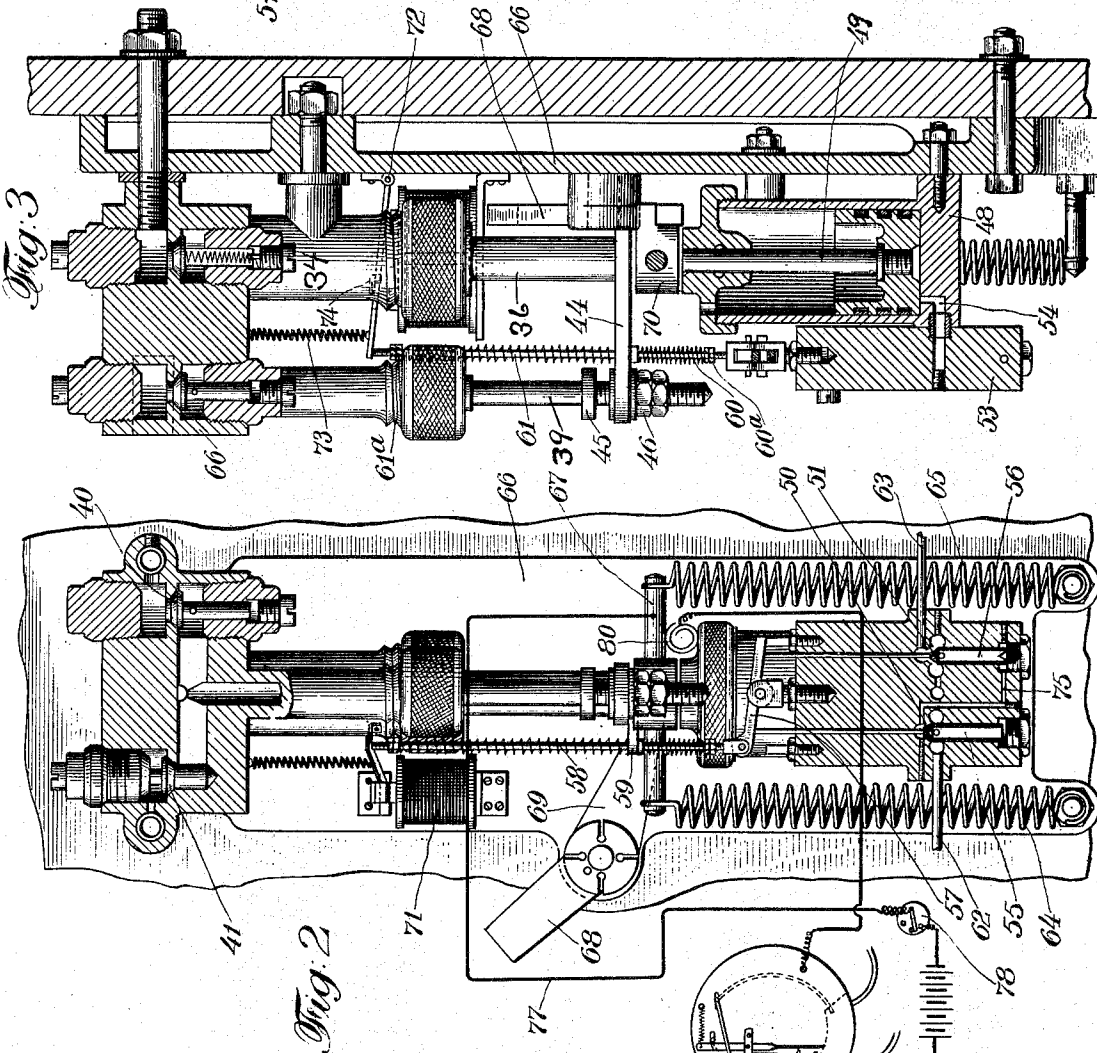
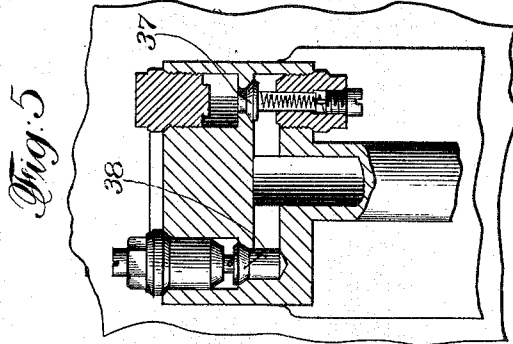
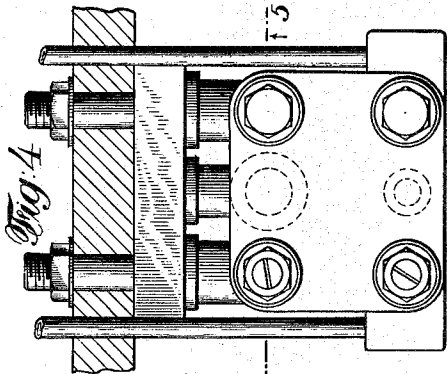
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Henry M. Ingraham

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3 SHEETS—SHEET 2.



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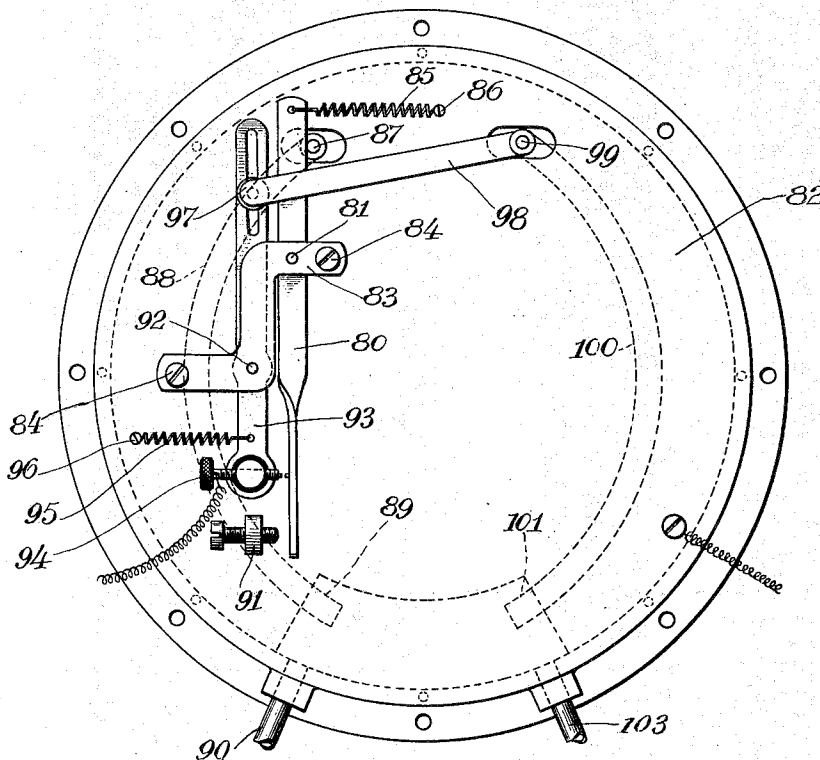
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3 SHEETS—SHEET 3.

Fig. 6



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UNITED STATES PATENT OFFICE.

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AUTOMATIC REGULATOR.

981,104.

Specification of Letters Patent. Patented Jan. 10, 1911.

Application filed November 18, 1909. Serial No. 528,371.

To all whom it may concern:

Be it known that I, EDWARD C. NEWCOMB, a citizen of the United States, and a resident of Scituate, in the county of Plymouth, in the Commonwealth of Massachusetts, have invented certain new and useful Apparatus in Automatic Regulators, of which the following is a specification.

My invention relates to automatic regulators which are adapted to regulate the supply of energy from a source of supply to distributing apparatus by which it is distributed to an additional apparatus or medium by which the energy is utilized or absorbed, the operation of the means for supplying energy from the source of supply to the distributor being primarily controlled by the amount of energy absorbed by or stored in the medium or apparatus by which the energy is utilized, and secondarily by means controlled by the amount of energy stored in the distributing apparatus which secondary controlling means so cooperates with the primary controlling means that the means for supplying energy to the distributor will be thrown out of action when a sufficient amount of energy has been stored in the distributor to restore the normal amount of energy to the medium or apparatus by which the energy is absorbed or utilized and in such manner as to compensate for the energy stored in the distributor with the result that condition of the apparatus or medium by which the energy is utilized will be at all times practically uniform notwithstanding the variations as to losses or loads to which the same may be subjected.

My invention is particularly adapted for use in connection with apparatus for the generation of steam or other vapor and more particularly in connection with apparatus which in whole or in part may be employed for carrying out the inventions set forth in United States Letters Patent No. 704,907 and No. 704,908, both dated July 15th, 1902, and in my application for patent for improvement in apparatus for generating steam filed May 18th, 1908, Serial Number 433,342.

In accordance with the preferred embodiment of my present improvements as set forth in the patents and application referred to, the generation of the steam is such that the thermal energy thereof is varied in substantial unison with the variations of de-

mand for such energy and in substantially the same degree with said variations of demand so that little reserve energy is required in the apparatus and yet the steam is delivered in a substantially predetermined condition as to temperature and pressure irrespective of the variations of demand. This is accomplished by varying the supplies of water or other fluid to be vaporized and the fuel for heating the same in substantial unison with the variations of demand for the thermal energy contained in the steam or other vapor and each according to definite quantitative relation to said variations of demand as more fully set forth in the patents referred to. I have found, however, that with the regulating devices shown and described in the patents above referred to, that considerable variations occur due to the reserve energy stored in the apparatus which interferes somewhat with the proper operation of the apparatus under certain conditions, and my present invention is adapted to compensate for the effect of this reserve energy.

As shown and described in the patents referred to, the means for supplying the water and fuel are operated or controlled by an engine driven by the steam delivered from the generator, the supplies being controlled independently of the speed of the engine.

In my application filed May 18th, 1908, Serial No. 433,342, for apparatus for generating steam, I have shown means for supplying water to the generator and fuel to the burner for heating the generator controlled independently of an engine or other apparatus by which the steam delivered from the generator is utilized, namely, by the pressure of the steam in the generator itself.

An object of my present invention is to provide means for supplying water to the generator and fuel to the burner for heating the generator which will compensate for the reserve energy stored in the apparatus and also for the fuel which is stored in the apparatus between the fuel pump and the burner, and which, or a portion of which will be vaporized and consumed in the burner after the pump has ceased to operate.

I do not wish to confine myself to the specific constructions shown and described as it is apparent that they may be varied

without departing from the spirit of my invention. In accordance with the preferred embodiment, however, the generator is constructed of coiled pipe forming a single continuous passage arranged with relation to the combustion chamber so that different parts of the generator are heated to different temperatures, the water being supplied to a cooler part so that it is gradually heated to the temperature of vaporization gradually vaporized and the steam superheated and delivered from a hotter portion of the generator.

Where a generator of the preferred type is employed to-wit, one having a continuous passage arranged to receive water at one end and to deliver steam at the other end, the pump-driving motor is preferably controlled through a relative wide range of duty by a relatively slight range of variations in the controlling condition of the fluid in the generator so that the condition of the generator will remain substantially uniform and the supplies of both water and fuel be varied in substantial unison with the variations of demand for the thermal energy of the steam or other vapor delivered from the generator and according to substantially definite quantitative relations to said variations in demand.

Preferably the pressure of the fluid in that part of the generator wherein the water is vaporized is employed as the primary controlling condition as any variation in the quantity of water in the generator or of the distribution of the heat in the generator is necessarily accompanied by a variation of the pressure of the fluid in the part of the generator referred to.

In order to compensate for the stored energy in the form of unabsorbed heat in the tubes of the generator and for the unconsumed fuel in the vaporizer, I have found it desirable to employ secondary means for correcting the primary means of the regulation just described, namely, means rendered operative by the pressure of the fuel between the pump and the vaporizer.

If the condition of the fluid in the part of the generator wherein the water is vaporized is maintained substantially uniform, the condition of the generator will remain substantially uniform.

In order that the steam may be delivered from the generator at a desired or predetermined temperature and pressure, means are provided whereby the relation between the supplies of the water and the fuel may be varied.

In accordance with a preferred embodiment of the present improvements, the pump driving motor is a steam motor connected with the generator. In order that this motor may act with the desired promptness and to the desired extent, it is preferably in

constant communication with the generator and its action is primarily controlled by means operated by the pressure at a certain point in the generator and secondarily by the pressure in the fuel pipe between the pump and nozzle of the vaporizer.

While any suitable fuel supply means may be used whereby the supply of fuel may be accurately regulated and quickly varied, a liquid fuel which may be supplied to a suitable burner by a pump is preferably employed. It is to be understood also that any suitable liquid other than water may be supplied to the generator.

For the sake of brevity I have herein referred to the variations of the thermal energy of the steam or other vapor delivered by the apparatus as variations of demand for steam energy.

It is not to be understood by the expression "substantial unison" as used herein that the relative variations between the demands for the supplies of the fluids are strictly simultaneous. The essential in this regard is that the variations be produced with sufficient promptness to maintain the apparatus in a practically predetermined condition. For instance, the pumps and motor for supplying the fuel and water are preferably capacitated to supply the same at a greater rate than is required by the demand for steam energy and said parts are operated intermittently, the mean supplies of the fluids being varied to correspond with the demand for steam energy, by variations of the frequency or duration of the operations of the pump or by variations of both frequency and duration of such operations.

The expressions "substantially in definite quantitative relation" and "substantially in predetermined quantitative relation" as used herein are not to be understood as necessarily referring to unchanging relations between the supplies of the fuel and water on the one hand and the demand for steam energy on the other hand for such relations may be made to vary. It is intended that these expressions shall comprehend such relations between the supplies of the fluids and the demand as will produce practically uniform results and maintain the apparatus in a practically predetermined condition.

My present invention consists in the novel improvements, combinations and constructions herein shown and described.

The accompanying drawings which are referred to herein and form a part hereof illustrate one embodiment of my invention and in connection with the description serve to explain the principles and constructions thereof.

Of the drawings Figure 1 is a view partly in section and partly in elevation illustrating my invention as applied to apparatus adapted to generate steam. Fig. 2 is a

front elevation partly in section of the pumps and pump operating motor for supplying water and fuel to the apparatus and also part of a form of means for controlling the motor. Fig. 3 is a vertical section of the same taken on the line 3—3 of Fig. 2. Fig. 4 is a plan view of the pumps. Fig. 5 is a vertical section illustrating certain details of the water pump, the section being taken on the lines 5—5 of Fig. 4. Fig. 6 is a plan view of my automatic regulating device.

While some of the advantages of my invention can be realized by the use of various forms of generators, the best results can only be obtained in connection with the main features of my improvements by the use of a generator having a continuous passage in which the water is gradually heated from its point of entrance until it is brought to the temperature of vaporization and is then gradually vaporized, only a small quantity of the liquid in the generator being maintained at the temperature of vaporization corresponding to the pressure at which the apparatus is operated.

In accordance with the particular embodiment of the invention illustrated, the generator is constructed of coiled pipe forming a single continuous passage adapted to receive the water at one end and to deliver the steam in a superheated condition at the other end.

As shown, the generator consists of six frustoconical pipe coils numbered 1, 2, 3, 4, 5 and 6, said coils being nested one within another and all being of substantially the same diameter at the larger end but successively longer from the outer coil to the inner coil so as to form an approximate cylindrical mass of heating surfaces. The coils are connected in series as by suitable connections 7, 8, 9, 10 and 11. The coils surround the combustion chamber and the convolutions of the coils are suitably separated from each other so as to provide passages for the flow of the products of combustion to pass between the convolutions of each of the coils successively from the innermost coil to the outermost coil.

The outermost coil is projected outwardly at its lower end and is connected to the supply pipe 15 and the innermost coil is projected outwardly at its lower end and is connected to the steam delivery pipe 16 so that the fluid is caused to flow from the outermost coil to the innermost coil in a general direction opposite to that in which the flow of the products of combustion takes place, whereby the heat of the products of combustion is efficiently absorbed and the fluid is gradually heated from the point of entrance to the point of delivery.

The total area of the passages for the products of combustion between the convolution of each coil is successively decreased

from the innermost coil to the outermost coil to correspond substantially with the decrease in the volume of the products of combustion due to the decrease in the temperature thereof. By reason of this construction the efficiency of the generator is high and the products of combustion are caused to flow in substantially the same path at all times so that the distribution of the heat in the generator remains practically uniform irrespective of the variations of the load. This generator is substantially like the generator described in the patents and application for patent hereinbefore referred to and will operate as described therein. The generator is preferably incased in a substantially cylindrical casing 17 between the lower part of which and the shield 12 is formed an annular discharge flue for the waste products of combustion.

Any suitable means may be provided to effect the combustion of the fuel. As shown, the burner comprises a perforated plate 18 between which and the plate 19 is provided a chamber adapted to receive a suitable mixture of fuel and air from a central mixing tube 20 and evenly distribute this mixture throughout the area of the perforated plate 18.

As shown, the mixing tube 20 is vertically arranged and extended upward through the center of the space inclosed by the generator coils through the center of the top plate 21 of the generator casing. To evenly distribute the mixture a distributing plate 22 is preferably arranged between the plates 18 and 19, said plate 22 being connected to the lower end of the mixing tube 20 and separated a suitable distance from the plate 19 at its outer edge.

Liquid fuel is supplied through a pipe 23 to a vaporizing coil 24 arranged above the burner, the vaporized fuel being led by pipe 25 to a nozzle 26 arranged in the mouth of the mixing tube 20, the area of the orifice of the nozzle 26 being so chosen that the vaporized fuel will be forced therethrough into the mouth of the mixing tube 20 at the desired high velocity, the area of the orifice of the nozzle 26 being so proportioned with reference to the bore of the pipe 23 and the capacity of the pump 35 that a high pressure will always be maintained in the pipe 23 and the vaporizer when the fuel pump 35 is in operation and the magnitude of the pressure therein will bear a direct relation to the rate at which fuel is being pumped to the vaporizer by the fuel pump 35 and the amount of fuel contained therein.

For the purpose of heating the fuel vaporizer to start the burner a suitable pilot burner is provided. As shown, the pilot burner consists of a hollow member 27 having a vaporizing passage in its lower end to which a suitable liquid fuel is supplied by a

pipe 27^a and from which the vaporized fuel is led through a nozzle regulated by a needle valve 28 to the combustion chamber in the member 27. The air necessary to support the combustion is supplied through perforations in the member 27 as shown. The pilot burner is protected by suitable perforated casing 29 having a cup shaped lower end adapted to receive a small quantity of alcohol or gasoline to start the burner. The pilot burner is designed to operate continuously to form an igniter for the main burner so that the latter is permitted to become extinguished when there is no demand for steam from the generator.

The vaporizer 24 of the main burner is preferably formed of small tubing having an ample heating surface in order that the fuel contained therein may be properly vaporized and the quantity of fuel that may be stored therein at any time will be as small as practicable so that the heat developed by the burner will vary as nearly as possible in substantial unison with the variations in the operation of the fuel pump. I have found, however that it is not possible to reduce the diameter of the tube below certain limits as otherwise it is likely to become clogged and cease to perform its functions.

The mixing tube 20 is preferably shielded from the heat of the combustion chamber by a tube 30 between which and the tube 20 a packing of refractory heat insulating material may be provided. As shown, the generator coils are supported by a casting 31 which rests upon a base ring 32 carried by suitable brackets, one of which is illustrated at 33.

As regards some features of the invention, the water may be supplied to the generator by any suitable form of pump and this pump may be driven by any form of motor, the operation of which may be promptly varied through a wide range of duty and the fuel may be supplied by any means adapted to maintain a predetermined relation between the supplies of fuel and water. As shown, the water is supplied to the generator by a pump 34 and the fuel is supplied to the burner by a pump 35, these pumps being of the single acting plunger type, as shown the water pump having a reciprocating plunger 36 and suitable suction and delivery valves 37 and 38 respectively as clearly shown in Fig. 5 and the fuel pump having a reciprocating plunger 39 and suction and delivery valves 40 and 41 respectively and the plungers 36 and 39 are caused to reciprocate in substantial unison by an arm 44 fixed on the plunger 36 and arranged to embrace the plunger 39.

The desired predetermined relation between the supplies of water and fuel may be obtained by making the areas of the two plungers 36 and 39 proportionate to the de-

sired relation between the volumes of water and fuel respectively and driving both plungers the same length of stroke. Preferably, however, the area of the fuel plunger is made slightly greater than that indicated and the stroke of the pump made correspondingly shorter than the stroke of the fuel pump, as by providing a suitable amount of lost motion between the fuel plunger and its operating arm 44 and in order that the effective displacement of the fuel plunger may be varied with relation to the displacement of the water plunger, means are provided whereby the lost motion between the fuel plunger and the arm 44 may be varied.

As shown, the plunger 39 is provided with a pair of collars or projections 45 and 46 between which the arm 44 plays with the desired lost motion, the amount of which may be varied by varying the distance between the said collars. As shown, the collar 46 is in the form of a pair of lock-nuts threaded on the lower end of the plunger.

The pumps may be connected to and driven by the motor in any suitable way. As shown, a steam motor is provided, the same including a single acting piston 47 mounted in a cylinder 48 and having a piston rod 49 arranged in line with the plunger of the water pump.

It will be understood that for the sake of clearness in the drawings, the pump and motor are drawn to a larger scale than the generator as represented in Fig. 1. As actually constructed, the pumps and motor are about three-fifths the size shown in proportion to the size of the generator as shown and the generator is constructed of three-quarter inch seamless tubing.

The steam may be admitted to and is discharged from the power cylinder 48 of the motor by any suitable form of steam distributing valve mechanism adapted to produce the required movements of the piston.

Preferably and as shown steam admission and exhaust valves 50 and 51 respectively are provided, the same consisting of reciprocating valves of the puppet type. As shown these valves are arranged in a steam chest 53 secured to one side of the power cylinder 48 and communicating therewith through a port 54. These valves may be alternately opened and closed by any suitable mechanism operated by the reciprocation of the steam piston or of parts moving therewith. As shown, the distributing valves 50 and 51 are operated by stems 55 and 56 respectively, said stems projecting upwardly through perforations in the valve chest 53 and arranged to be acted upon by the opposite ends of the lever 57 pivotally mounted at an intermediate point on the fulcrum post adjustably secured on the steam chest 53. The lever 57 is oscillated by a rod

58 pivotally connected to the lever 57 and passing through an arm 59 fixed on the arm 44. The motions of the arm 59 are communicated in each direction to the rod 58 by means of springs 60 and 61 arranged on the rod 58 on opposite sides of the arm 59. In order that the tension of these springs may be varied adjusting nuts 60^a and 61^a are provided for the respective springs 60 and 61. Steam is admitted to the cylinder over the valve 50 when it has been unseated through a pipe 62 and the steam is exhausted through and around the valve 51 and may be delivered at any desired point through the exhaust pipe 63.

It will be seen that by suitably tensioning the springs 60 and 61 the valves 50 and 51 will be alternately opened and closed as the parts reach or approach the opposite ends of their strokes so that the piston will be alternately driven upward and allowed to descend as required to operate the pumps, the valves 50 and 51 being raised and held against their seats by the steam pressure at the proper time during the operation of the motor. While the motor may be made double acting as by duplicating the valve mechanism described, it is preferred to make it single acting and cause the downward or idle stroke thereof together with the suction strokes of the two pumps by a spring or springs. As shown two tension springs 64 and 65 are provided, the same being arranged between suitable supports on the lower end of the supporting frame 66 of the pump structure and the cross arm 67 fixed on the lower end of the water plunger 36.

In order that the pumps may be operated by hand as required to start the apparatus, a suitable hand lever 68 is provided the same as shown being pivoted on the supporting frame 66 and having an arm 69 adapted to engage a shoulder or ledge 70 on the hub of the cross arm 67.

While the pump driving motor may be controlled in various ways, preferably as shown, it is controlled by the intake valve 50. To this end the condition as to pressure of the steam in the generator is utilized as the primary means of controlling the motor and the motor is connected by the pipe 62 to a predetermined point in the generator, to-wit, to a point near the discharge end of the generator in order that the steam by which the motor is operated may be properly superheated.

As shown in the drawings the pipe 62 connects with the discharge pipe 16 at a point just outside of the shell of the generator.

Assuming that the parts are in the position shown in Fig. 2 it will be seen that the valve 50 is held to its seat by the pressure of the steam and that this pressure is opposed by the pressure of the spring 60. In

my application hereinbefore referred to, the tension of the spring 60 was so adjusted and balanced against the steam pressure which tended to seat the valve that a slight fall in the steam pressure would cause the valve to be forced from its seat by the spring 60 which would then tend to continue to carry it away from its seat. In practice, however, I found that this method of controlling the operation of the motor is not sufficiently sensitive or certain to insure the prompt regulation of the pumps for feeding fuel to the vaporizer and water to the generator and that this uncertainty and lack of promptness in operation resulted in undesirable fluctuations in the conditions in the generator. I prefer therefore to so adjust the tension of the spring 60 that its force will not be sufficient to unseat the valve 50 without the aid of the mechanism which I will now describe, which consists of an electro-magnet 71 secured to the frame 66. The armature of this magnet is pivotally secured at 72 to the frame 66. To the other end of the armature is secured one end of a spring 73, the other end of which is secured to the pump body. The spring 73 tends to rock the armature away from the magnet and the rocking movement of the armature is limited in its upward movement by a stop 74 mounted on the pump. The armature is also so mounted that its free end will contact with the upper end of the rod 58 and depress the same and rock the lever 57 and force the valve 50 from its seat whenever the magnet is energized. When the valve 50 is forced from its seat the steam from the pipe 62 passes over and around the valve 50 through the passage 75, upward through the hollow exhaust valve 51 forcing it against its seat and escaping through the restricted passages 76, passes through the passage 54 into the cylinder 48 beneath the piston 47 causing the piston to rise and make one complete upward stroke. The upward stroke of the piston causes the arm 57 to be rocked by the mechanism described and depress the valve 51 from its seat.

As the parts approach the upward limit of their stroke, the spring 61 will be put in compression and this spring may be so adjusted that it will force the valve 51 off its seat at approximately the end of the upward stroke of the motor even though the pressure of the steam be greater than it was when the valve was opened. The opening of the valve 51 will permit the closing of the valve 50 which will be forced against its seat by the steam pressure so that the steam will be shut off from the cylinder and the steam in the cylinder will be permitted to escape around the valve 51 so that the piston together with the pump plunger may be returned by the springs 64 and 65. The speed

at which the motor operates may be controlled in any desired manner. The power stroke may be regulated by suitably restricting the flow of the water from the water pump to the generator as by means of the valve 15^a in the water supply pipe. By having the motor in constant communication with the generator, it is kept in a heated condition and the steam when admitted to the power cylinder will be immediately effective to cause the prompt operation of the motor.

In the preferred embodiment of my invention I utilize the pressure of the fluid in that part of the generator wherein the water is vaporized as the primary controlling means for making and breaking the electric circuit of the electro-magnet. To this end I have provided a source of electricity 77 in the circuit of which is included the electro-magnet 71, a switch 78, the automatic regulator 79 and the contact spring 80 which is mounted on the frame 66 and insulated therefrom and so positioned that when the arm 67 has been carried down to its lowest position at the completion of the return stroke of the motor the spring 80 will contact with the arm 67 and complete that portion of the electric circuit.

My automatic regulator 79 is provided with a lever 80^a pivoted at 81 to the frame 82 and the yoke 83 which is secured to the frame 82 by pillar screws 84. To the upper end of the lever 80^a is secured one end of a spring 85, the other end of which is secured to a stud 86 mounted in the frame 82. The tension of the spring 85 tends to force the upper end of the lever 80^a against a stud 87 mounted in an extension on the end of a Bourdon tube 88, the lower end of which is secured to the frame 82 at 89. The Bourdon tube 88 is connected to and communicates with the generator by means of a pipe 90 which is connected to the coupling 11 which is at or near that part of the generator wherein the water is vaporized and where any variation in the quantity of water in the generator or of the distribution of the heat in the generator is necessarily accompanied by a corresponding variation of the pressure of the fluid in that part of the generator.

Mounted on the frame 82 is an adjustable stop 91 by means of which the movement of the lower end of the lever 80 from right to left is limited. Also secured between the frame 82 and the yoke 83 by means of a pivot 92 is a lever 93 on the lower end of which is mounted an adjustable insulated contact screw 94 which is connected with the source of electricity. To the lower end of the lever 93 is also connected one end of a spring 95, the other end of which is connected to a stud 96 mounted in the frame 82. The upper end of the lever 93 is slotted to receive an adjustable linkage 97 which is secured to the end of a rod 98, the other end

of which is pivotally secured at 99 to an extension on the end of a Bourdon tube 100, the other end of which is secured to the frame 82 at 101. The lower end of the Bourdon tube 100 is connected to and communicates with the fuel pipe 23 at 102 by means of a pipe 103 through a restricting valve 104 adapted to prevent undue fluctuations of pressure in the pipe 103 and the Bourdon tube 100 which may be produced in the pipe 23 by the intermittent action of the fuel pump and to compel the Bourdon tube 100 to register the mean pressures which may exist in the pipe 23.

It will be understood that with the mechanism described the circuit will in the first instance be completed whenever the pressure in the generator falls below the normal predetermined limit but that the circuit having once been completed and the motor thrown into action, that thereafter the circuit will be broken and the motor thrown out of action whenever a sufficient amount of fuel has been injected into the pipe 23 and the vaporizer and there remains unconsumed to raise the pressure in the generator to the predetermined normal point if the load on the generator were removed and consequently that when a load is being sustained by the generator and its pressure reduced below the predetermined point, the action of the motor will be intermittent and the circuit completed whenever the amount of fuel stored in the pipe 23 and the vaporizer is insufficient in amount to restore the pressure in the generator to the predetermined normal limit if the load on the generator were removed, and that the contact will again be broken and the motor and pumps thrown out of action whenever the amount of fuel stored in the pipe 23 and the vaporizer would be sufficient to restore the pressure in the generator to the predetermined normal limit if the load on the generator were removed.

The pressure to be maintained in the generator is determined by the regulation of the adjustable contact 94, the contact point 94 being so adjusted that the point thereof will contact with the lever 80 when any substantial reduction below the normal predetermined point has taken place and it is obvious that if the adjustable contact screw 94 is screwed toward the right, a higher pressure will be maintained in the generator, and if it is screwed toward the left, a lower pressure will be maintained therein.

Shifting the link connection 97 away from the fulcrum of the lever 93 will reduce the motion of the lower end of this lever and consequently reduce the range of the compensating mechanism.

Shifting the link connection 97 toward the fulcrum point of the lever 93 will increase the degree of compensation. The correct adjustment of the link connection 97 on the

lever 93 is determined by experiment and it is apparent that the gage may not only be adjusted to compensate for the amount of unconsumed fuel stored in the pipe 23 and the vaporizer 24 but also for the latent heat stored in the generator which has not been absorbed by the fluid contained therein. The function of the adjustable stop 91 is to limit the movement of the lower end of the lever 80 from right to left so as to break the contact whenever the fuel would otherwise tend to pump into the pipe 23 and the vaporizer 24 a greater quantity of fuel than the apparatus could efficiently consume.

It is to be understood that my invention in its broader aspects is not limited to the particular construction shown nor to any particular construction by which it has been or may be carried into effect as the construction of the apparatus may be greatly varied without departing from the main principles of the invention and without sacrificing its chief advantages.

The word "supply" is used to designate the supply which has been taken from the source of supply, but which has not yet been utilized.

Claims.

1. An automatic regulating device comprising in combination with a source of supply, and means for supplying and means for utilizing the supply, primary regulating means adapted to control said supplying means and to be rendered operative by the failure of the supply to maintain a predetermined condition in said utilizing means and secondary regulating means, rendered operative and controlled by the supply and adapted to so regulate such primary regulating means as to compensate for the supply before it has been utilized.

2. An automatic regulating device comprising in combination with a source of supply, means for supplying and means for utilizing the supply, primary regulating means adapted to control the supplying means and to be rendered operative by the failure of the supply to maintain a predetermined condition in said utilizing means and secondary regulating means rendered operative and controlled by the supply and adapted to so regulate such primary regulating means, that the supply will be so controlled before the predetermined condition has been restored as to compensate for the supply before it has been utilized.

3. An automatic regulating device comprising in combination with a generator constructed to receive water and deliver steam, a burner, a pump for supplying fuel to the burner, a pump for supplying water to the generator, and a motor for driving said pumps, primary regulating means adapted to throw said motor into action and to be rendered operative by the failure of the pumps

to maintain a predetermined condition in the generator and secondary regulating means rendered operative and controlled by the fuel supplied by the fuel pump adapted to so regulate such primary regulating means as to compensate for the unconsumed fuel which has been supplied by the fuel pump.

4. An automatic regulating device comprising in combination with a generator adapted to receive water and deliver steam, a burner, means for supplying fuel to the burner, and means for supplying water to the generator, primary regulating means for throwing into operation the means for supplying fuel to the burner and the means for supplying the water to the generator, rendered operative by the failure of the means for supplying fuel to the burner and water to the generator to maintain a predetermined condition in the generator and secondary regulating means, rendered operative and controlled by the fuel supplied by the means for supplying fuel adapted to so regulate such primary regulating means as to compensate for the unutilized fuel supplied by the means for supplying fuel.

5. An automatic regulating device comprising in combination with a generator adapted to receive water and deliver steam, a burner, means for supplying fuel to the burner, and means for supplying water to the generator, primary regulating means rendered operative by the failure of the means for supplying fuel to the burner and water to the generator to maintain a predetermined condition in the generator, for throwing into operation the means for supplying fuel to the burner and secondary regulating means rendered operative and controlled by the fuel adapted to so regulate such primary regulating means as to compensate for the unconsumed fuel supplied by the means for supplying fuel.

6. An automatic regulating device comprising in combination with a generator adapted to receive water and deliver steam, a burner, means for supplying fuel to the burner and means for supplying water to the generator, a Bourdon tube in communication with the generator, primary regulating means actuated by the Bourdon tube in communication with the generator for throwing into operation the means for supplying fuel to the burner and the means for supplying water to the generator, a Bourdon tube in communication with the fuel supplying means, and secondary regulating means, operated and controlled by the Bourdon tube in communication with the fuel supplying means, adapted to so regulate such primary regulating means as to compensate for the unconsumed fuel supplied by the means for supplying fuel to the burner.

7. An automatic regulating device comprising in combination with a source of sup-

ply and means for supplying and means for utilizing the supply, electrical mechanism adapted to render the supplying means active, primary regulating means adapted to complete the circuit in which such electrical mechanism is included whenever the supply fails to maintain a predetermined condition, and secondary regulating means rendered operative and controlled by the supply and adapted to so regulate such primary regulating means as to compensate for the supply before it has been utilized.

8. An automatic regulating device comprising in combination with a source of supply and means for supplying and means for utilizing the supply, electrical mechanism adapted to render the supplying means active, primary regulating means adapted to complete the circuit in which such electrical mechanism is installed whenever the supply fails to maintain a predetermined condition, and secondary regulating means rendered operative and controlled by the supply and adapted to so regulate such primary regulating means as to break said electrical circuit when the supply is sufficient to restore the predetermined condition.

9. An automatic regulating device comprising in combination with a generator, a burner and means for supplying fuel to the burner, a Bourdon tube in communication with the generator, primary regulating means actuated by the Bourdon tube in communication with the generator for throwing into operation the means for supplying fuel to the burner, a Bourdon tube in communication with the fuel supplying means, and secondary regulating means operated and controlled by the Bourdon tube in communication with the fuel supplying means adapted to so regulate such primary regulating means as to compensate for the unconsumed supply of fuel stored in the means for supplying fuel to the burner.

10. An automatic regulating device comprising in combination with a generator, a burner and means for supplying fuel to the burner, electrical mechanism adapted to render the supplying means active, a Bourdon tube in communication with the generator adapted to complete the circuit in which such electrical mechanism is included whenever the burner fails to maintain a predetermined condition in the generator, and a second Bourdon tube in communication with the fuel supplying means adapted to break said circuit whenever the supply of fuel stored in the means for supplying fuel to the burner is sufficient to restore such predetermined condition in the generator.

11. An automatic regulating device comprising in combination with a source of supply, and means for supplying and means for utilizing the supply, primary regulat-

ing means adapted to control said supplying means and to be rendered operative by the failure of the supply to maintain a predetermined condition and secondary regulating means, rendered operative and controlled by the supply and adapted to so regulate such primary regulating means as to compensate for the supply before it has been utilized and means for adjusting the action of the secondary regulating means upon the primary regulating means.

12. An apparatus for supplying energy including in combination a burner, a generator constructed to receive water and deliver steam, a pump for supplying fuel to the burner, a motor for driving said pump, primary regulating means rendered operative, by variations in the pressure of the fluid in the generator for throwing the motor into and out of operation, and secondary regulating means controlled by variations of pressure in the vaporizer for regulating such primary regulating means so as to compensate for the fuel stored in the burner.

13. An apparatus for supplying energy including in combination a burner, means for utilizing the heat generated by the burner, means for intermittently supplying fuel to the burner, primary regulating means rendered operative by changes in the condition of the means for utilizing the heat generated by the burner for throwing the means for supplying fuel to the burner into and out of operation, and secondary regulating means controlled by the latent fuel in the burner for regulating such primary regulating means so as to compensate for the fuel stored in the burner.

14. An apparatus for supplying energy including in combination a burner, a generator constructed to receive water and deliver steam, a pump for supplying fuel to the burner, a pump for supplying water to the generator, a motor for driving said pumps, primary regulating means rendered operative by a reduction of the pressure of the fluid in the generator for throwing the motor into action, and secondary regulating means rendered operative by variations of the pressure of the fluid in the burner adapted to so regulate such primary regulating means that the motor will be thrown out of action before the predetermined pressure in the generator has been restored and so as to compensate for the fuel stored in the burner.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

EDWARD C. NEWCOMB.

Witnesses:

ENOS THROOP GEER,

E. A. PEARCE.